Space Weather Technical Forecast

Issued on Saturday 29 March 2025 at 00:15 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Increased Chance of Minor/Moderate (R1/R2) radio blackouts. Decreasing Chance of Minor Geomagnetic Storm G1. Active electron fluence Expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity recorded at GOES16 and 18 rose to High in the period, with a peak X1.1 observed at 28/1520UTC from the vicinity of AR4046 and the neighbouring eastern solar horizon. This was followed by an M1.5 and M2.8 from the vicinity of a possible oncoming second eastern limb sunspot region.

There are up to six regions on the current disc, with AR4041 having faded in the northern central part of the facing side as a new unipolar spot developed in the western solar hemisphere. Changes in visible active regions have been limited in the period, with a slow spreading tendency visible in AR4043 in the northeast. The main activity came from the vicinity of the apparently relatively magnetically straightforward AR4046, however there appears to be at least some connection further east to possibly unseen regions on or over the limb.

Coronagraph imagery showed two main events in the period - firstly a far-sided western solar hemisphere Coronal Mass Ejection (CME) seen through the UTC afternoon. Secondly, a large and energetic east limb CME associated with the X1.1 flare. Neither event impinges on Earth in the forecast period, and no new CMEs are en route.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured by ACE at L1, showed a gradual waning of a fast wind emanating from CH25/+.

The solar wind speed fell from Strong levels and 775km/s, reaching 600km/s by the period's end. The solar wind density was level and within single figures ppcc throughout, mainly below 1ppcc. The IMF was at Background levels below 7nT, with the north-south component varying between +/-5nT. The phi angle was positive (away from the Sun) throughout.

The net result of the above solar wind measures was for Quiet to Active geomagnetic activity, peaking with a provisional Kp 4o in the 21-24UTC interval.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels, but showed a possible very slight enhancement in the wake of the X1.1 flare in 10MeV - still remaining below 1pfu even at peak.

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High energy electron flux (greater than 2 MeV) at GEO reached High flux and 2820pfu at 28/1800UTC. The 24-hour fluence was below the Active threshold, but on a rising trend, with the observed 24-hour integrated fluence at 28/2359UTC 7e7pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: The chances of both M and X class activity have been revised upwards slightly relative to recent guidance, with the probable arrival of up to two large eastern limb regions. M-class flares are now rated at a flat 'Chance' throughout, with a Slight Chance of X-class. No significant regions depart the disc.

Solar Wind / Geomagnetic Activity: No CMEs feature in the four-day forecast. The current fast wind from CH25/+ carries an ongoing Chance of giving isolated G1 Minor Geomagnetic Storm intervals at first, otherwise falling to Active and then Unsettled into the new UTC working week. There is then a possible minor resurgence due on 01 April from a comparatively minor coronal hole (unnumbered), with a further Slight Chance of G1.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at Background levels, with a negligible chance of enhancement from any larger flares given their likely far eastward emission locations.

High energy electron flux is Expected to breach Active early in the period, probably then remaining above for the four days, with slightly reduced confidence by 01 April with any further geomagnetic activity from a second - minor - coronal hole.

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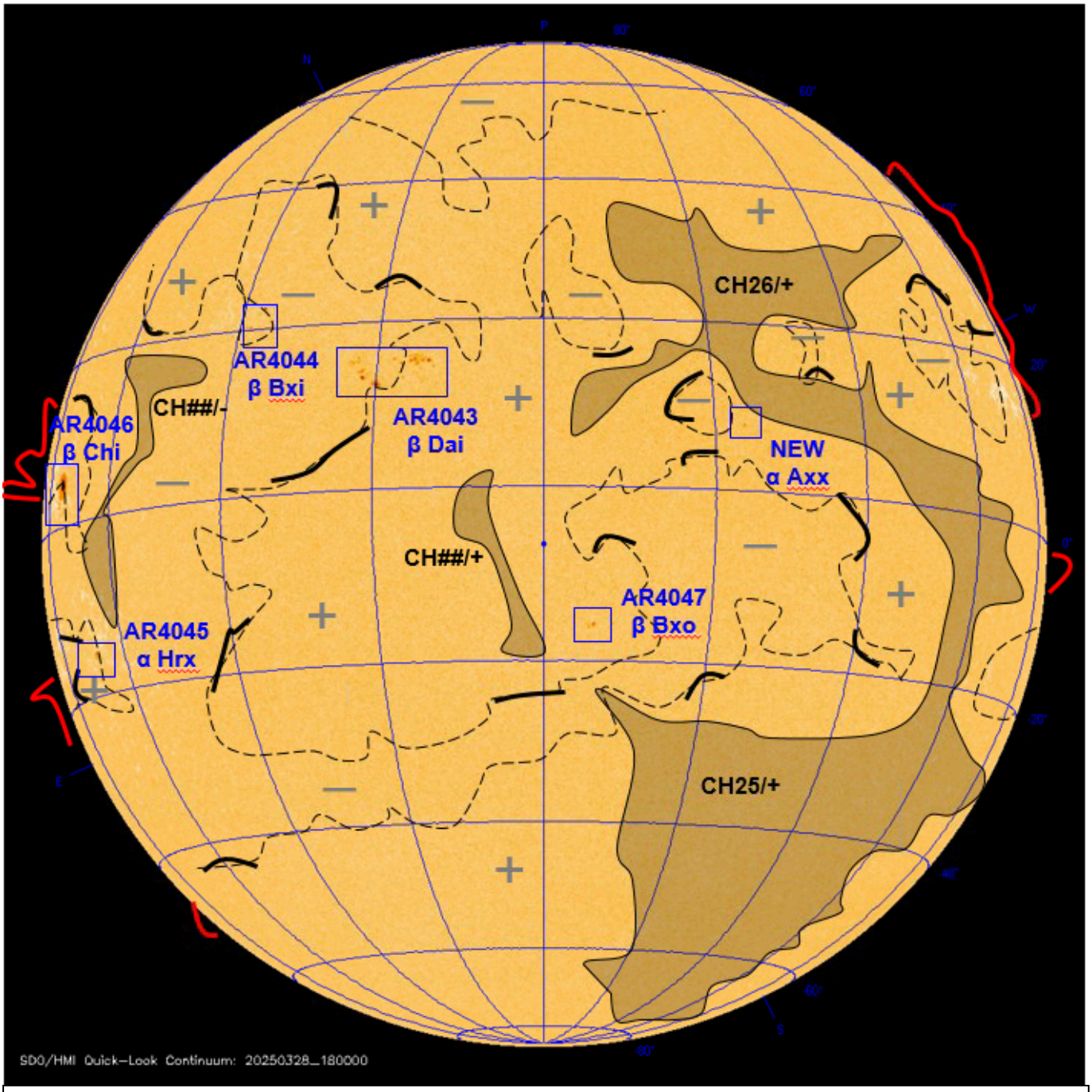
Figure 1: Solar synoptic map, valid 28/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no definitively Earth-directed CMEs in the forecast at present. An eruption from 25 March may give a slight chance of a glance on 29 or 30 March as indicated by the latest MOSWOC Enlil ensemble forecast, although this is low confidence, and a miss is more likely.

The current CH25/+ fast wind now looks to be waning, although there is some uncertainty as to how sustained this may be as there is a possible faint link between CH25 and 26 lying near 10N on the disc. In addition, there is then possibly a fragmentary positive polarity coronal hole near the solar meridian at present, although any resurgence from this feature would likely be very small. MOSWOC Enlil output is considered to be providing good guidance on the whole in indicating a gradual declining trend in the wind speed. The slight reprise on 01 April is perhaps then related to the aforementioned minor unnumbered coronal hole. Overall, MOSWOC Enlil follows a similar trend to the previous rotation as regards the larger persistent CH feature. Solar winds should most likely continue to decline to Slightly Elevated levels by 31 March, with a minor increase in the chances of G1 into the new calendar month - should the smaller coronal hole then manifest.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	10	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
25/1741 UTC	Partial	Filament eruption	SE	1300 km/s	29/1800 UTC	Low confidence as modelled on limited availability of imagery.

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Figure 2: Latest MOSWOC deterministic run (badge time 28/1800UTC) showing a faint uptick in solar wind speed, perhaps the result of a minor fast wind from a central coronal hole. The downward trend in the current fast wind from CH25/+ is considered good guidance in the mean time.

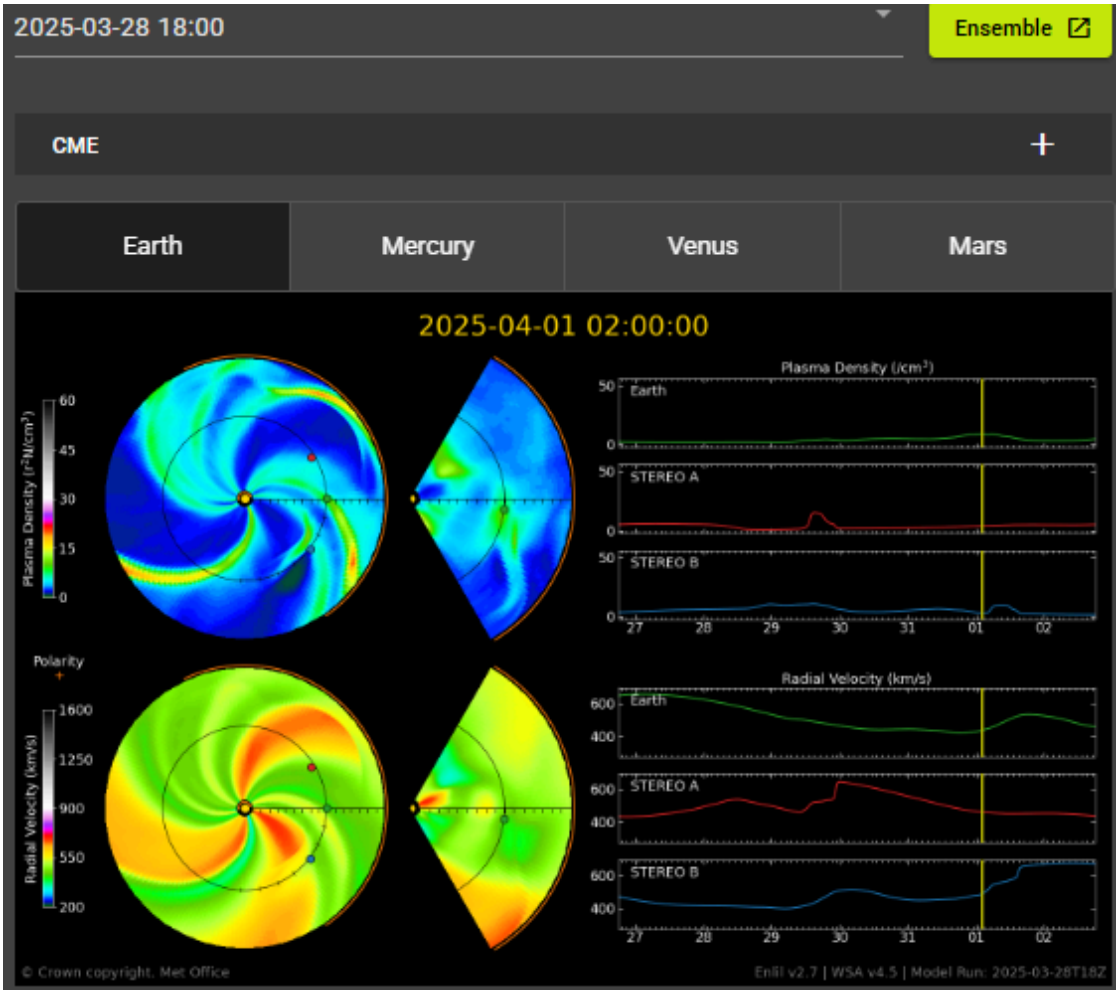

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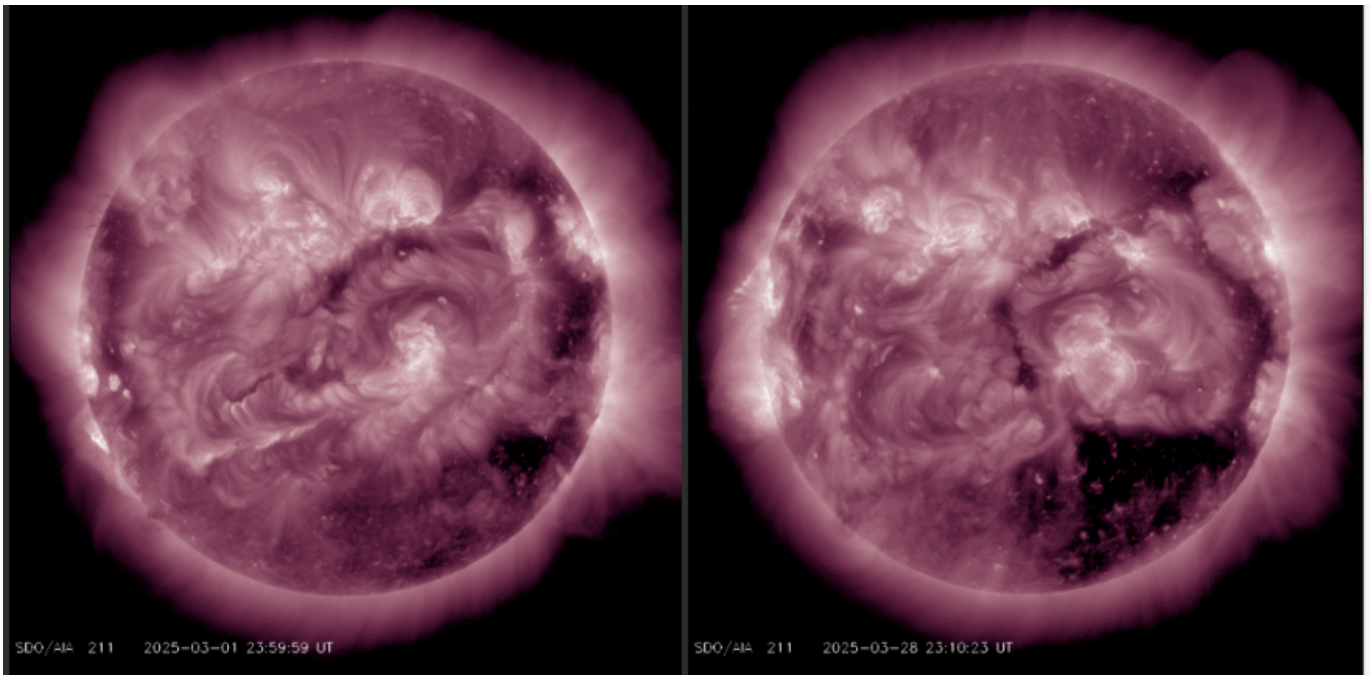
Figure 3: AIA211 imagery of the previous (01 March) and current (28 March) coronal hole configurations, with coronal holes showing close matches for the solar equatorial portion of the disc at least.



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Radio Blackouts - X-Ray Flares

Solar activity abruptly increased to High in the past 24 hours, with an eastern limb X1.1 followed by an M1.5 and M2.8. The fact that these were from apparently independent sources (northern and southern solar hemisphere respectively) implies that there may be up to two relatively complex oncoming regions, with the magnitude of activity relatively unusual were either merely to be prominence eruptions. There remains flux looping visible in AIA171 for example at both locations even after the flares, and far-side soundings show at least some recent returns for the southern region.

The Earth-facing disc is otherwise relatively simple, with only slow changes observed in the largest regions of AR4043 in the northeast and AR4046 in the far northeast. The latter of these may be in some way connected to the X-class event, with some trailing spot detail perhaps hidden by the narrow viewing angle in its otherwise simple Zurich Cho designation.

All considered, no significant regions depart in the four days, and the oncoming regions are perhaps already present, leading to a level trend. Both M and X-class activity have been tentatively raised throughout relative to the visible regions' raw flare risk values. This is on the assumption that the precise raised level will be revised when the complexity of any limb regions is known.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	50	50	50	50
Very Active	**R3-R5 (X Class)**	Yes	15	15	15	15

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Figure 4: AIA171 imagery of the oncoming eastern limb at 28/2300UTC, thought to be showing numerous magnetic connections to two as yet unseen active regions over the eastern solar horizon.

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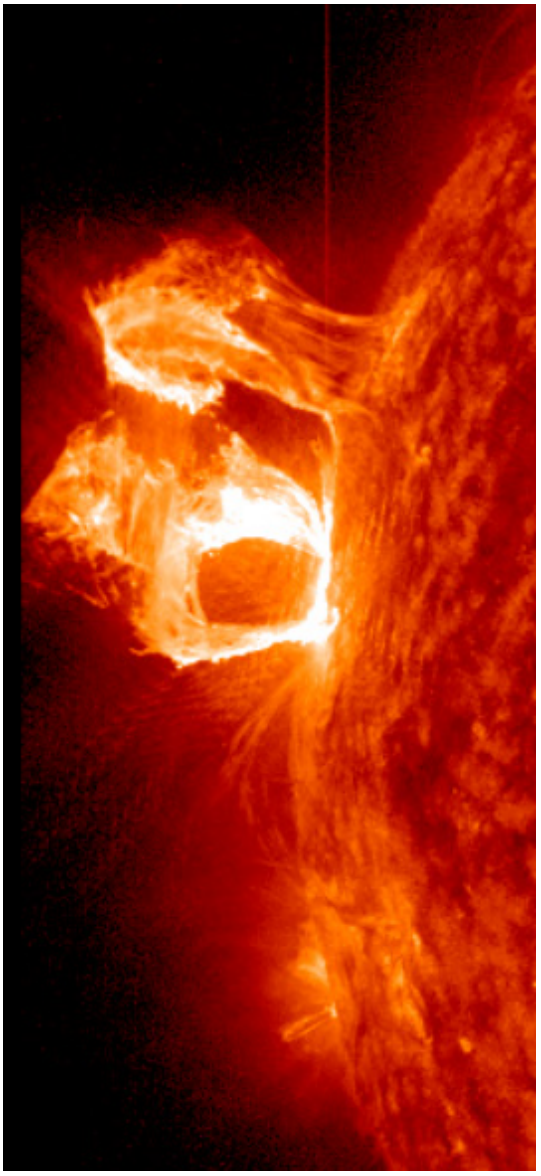
Figure 5: CME(s) generated from the X1.1 flare, seen in AIA304.



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux was at Background levels but showed a very slight response to the east limb X1.1 in the UTC afternoon of 28 March, still remaining below 1pfu even at peak. Given the dearth of western solar hemisphere sunspot regions, the daily risks of S1 or greater remain low, however the chances do gradually increase in the period with the westward advance of the far eastern groups.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	2	2	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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Figure 6: GOES18 X-ray flux and proton spectrum, showing a slight and gradual enhancement below 1pfu in 10MeV after the X1.1 flare.

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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2 MeV) is Expected to surpass Active 24-hour integrated fluence into the start of this four-day period in the wake of CH25's Strong fast wind. The diurnal flux has already exceeded its relevant analog from last pass, and as geomagnetic activity wanes through the coming UTC weekend, there should be little to suppress counts at GEO. MOSWOC Enlil suggests a minor fast wind may feature on 01 April, which may provide a minor rise in geomagnetic activity to make the continuation of Active fluence into the new month slightly less certain.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	80	90	90	80
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	5	5	5

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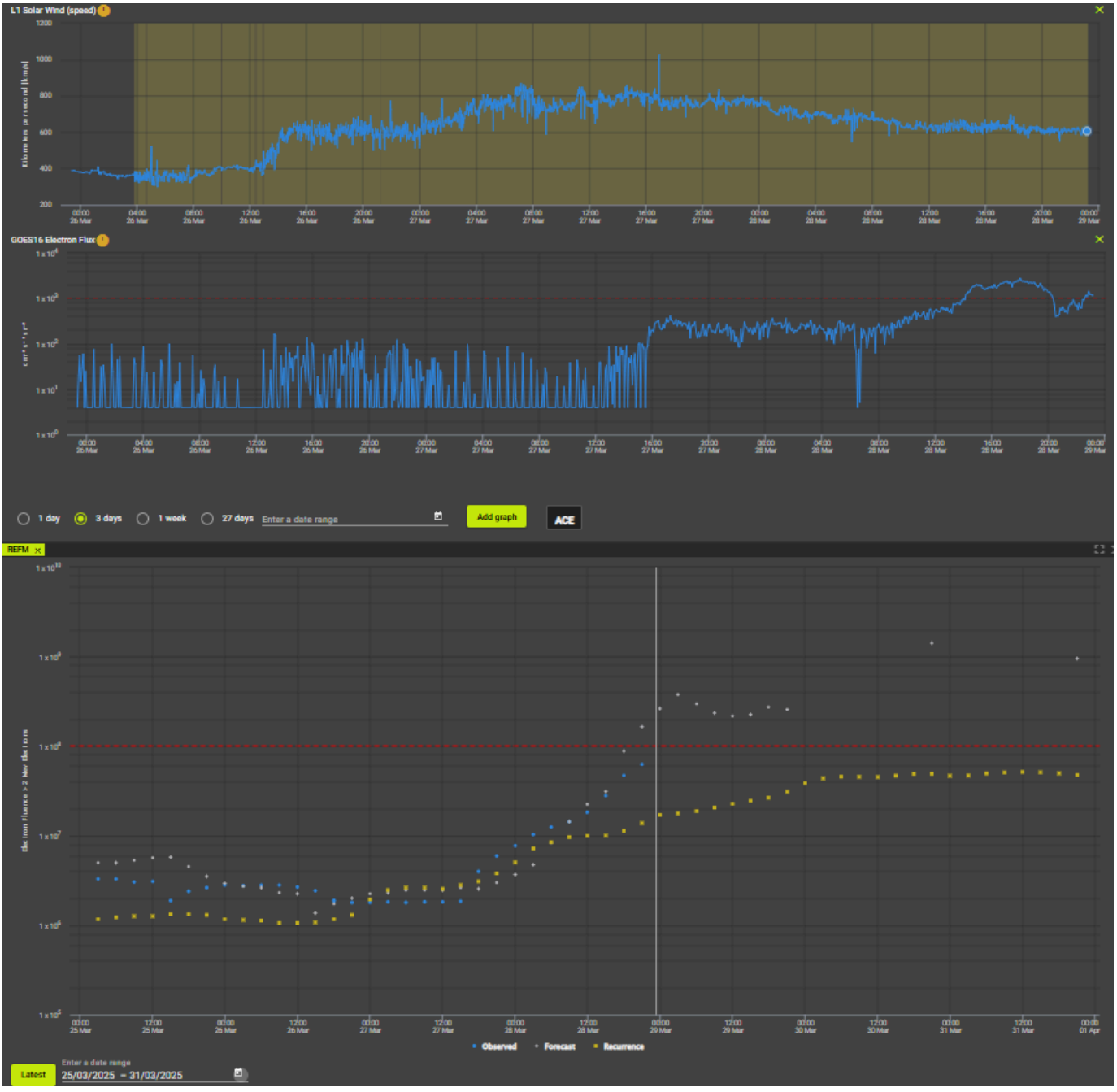
Figure 7: Past 72 hours in L1 solar wind speed, showing fast wind from CH25/+, resultant GOES16 high energy electron trace and 24-hour fluence trend (blue dots). The day-on-day increase in flux and fluence is expected to continue and may then survive the whole four-day period.



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